

A PLANNING PROGRAM FOR WORCESTER POLYTECHNIC INSTITUTE

THE FUTURE OF TWO TOWERS

PART III: A MODEL

"to help make our good college an excellent one"

The Faculty Planning Committee

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SEPTEMBER 1969

WORCESTER, MASSACHUSETTS

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## SUMMARY

It should be the goal of the Worcester Polytechnic Institute to teach its science and engineering-oriented students to learn for themselves and to develop in them an understanding of the interplay between technological advance and human need.

A program is presented for accomplishing this goal in which projects and independent study are a major educational tool, thus providing realistic and intimate learning situations for both students and faculty. To promote an understanding of relationship to human need, many of the projects will have social significance. Courses would be offered to bring coherence to information gained in the projects, to supply techniques in specific areas as required, and to provide a transition to the unstructured program.

It is proposed that requirements for the degree of Bachelor of Science be based primarily upon ability to learn rather than completion of prescribed courses. Suggested requirements are : advanced-level work on two projects, two year residence, a comprehensive examination in a particular study area, and two sufficiency examinations in areas other than that of the comprehensive.

To execute the proposed program a re-organization of the College is indicated. The academic standards and program are the responsibility of a Vice-president and an Academic Council (representing students, faculty, and administration). Student academic needs are co-ordinated with the operation through a Council of Advisors. Under the proposed unstructured curriculum, the advisor assumes a major role. He must help his students select appropriate projects and guide them to relevant courses. The actual educational functions are the responsibility of a Dean of Program Operations (responsible for the project and independent study work) and a Dean of Academic Resources.

An examination of the logistics indicates that the program can be carried out with a student/faculty ratio of 15:1. Although a significant increase in ancillary staff is required, the program appears to be financially feasible. The report also contains rough estimates of the costs of a three-year implementation program.



An area of equal importance to the academic program is that of co-ordination of community life with the academic purpose. Ten possible living arrangements and some basic questions are given, but this area awaits the thought and efforts of the students for full development.

Many details of the program remain to be worked out, requiring the efforts of the entire College. Appropriate sub-committees and their make-up are indicated.

## A GOAL FOR WORCESTER POLYTECHNIC INSTITUTE

It is the goal of Worcester Polytechnic Institute to bring into the second century of its existence a new, dynamic version of its great Two Tower tradition. In its first century WPI pioneered the integration of science and shop; in its second century WPI will pioneer in scientific service to society.

The WPI graduate of the future must have an understanding of a sector of science and technology and a mature understanding of himself and the needs of the people around him. While an undergraduate he must demonstrate that he can learn and can translate his learning into worthwhile action. He must learn to teach himself those things that are needed to make his actions socially significant. A WPI education should develop a strong degree of self-confidence, an eagerness to contribute to the community beyond oneself, and an intellectual restlessness, a spur to continued learning.



## I INTRODUCTION.

During the seven months of its existence the President's Planning Group endeavored to develop an understanding of the present status of WPI and to develop a set of possible objectives generally. The results of this work were presented in two reports, "The Future of Two Towers" and "The Future of Two Towers, Part II". During the past summer the faculty-elected Planning Committee has attempted to synthesize these results into a proposed overall goal and a corresponding model program of education. It is the purpose of the present report to present that synthesis for consideration by the College. Many details remain to be considered, but the Committee believe that the suggested program is educationally sound, meets a need for students and society, and deserves the attention needed to develop further details.

The proposed EDUCATIONAL PROGRAM (II), the suggested ORGANIZATION OF THE COLLEGE (III), discussion of CO-ORDINATION OF COLLEGE COMMUNITY LIFE WITH ACADEMIC PURPOSE OF THE COLLEGE (IV), and THE LOGISTICS OF PROJECTS AND INDEPENDENT STUDY (V) are discussed in this report. Section VI shows a procedure for further developing the model. An Appendix outlines the estimated cost of the program. While the report does not discuss the graduate program, it assumes that that will enhance the proposed undergraduate program.

The remainder of this section discusses the principal considerations which led to the proposed program.

### A. Worcester Polytechnic Institute and Educational Innovation.

There is a growing feeling throughout the nation that many science and engineering educators have become so concerned with a narrow form of professionalism that they fail to react adequately to disturbing signs around them. For over a decade we have seen a loss of interest in engineering on the part of high school students; the disenchantment of students enrolled in engineering programs is notorious; and we have heard much about the importance of relating science and engineering to the needs of people. Many papers have been presented by national leaders which deplore the "lack of concern" on the part of the specialists and cite repeatedly the need for the humanist-professional. The need for some basic changes in the approach to



the education of scientists, engineers, and those who would work with them has been widely recognized.

The willingness to innovate or make significant changes in existing educational programs has been given lip service, but, with few exceptions, little has been done to renovate the structure beyond "painting the trim". There are many reasons for this general lack of activity in educational innovation. Sheer size of some institutions prevents development of new climates; finances are always tight; concern about "playing it safe" with accrediting agencies hinders creativity; but, in the long run, it is probably the ancient alliance of mental and structural inflexibility that really prevents new developments.

The purpose of the independent college has been the subject of many thoughtful writings, but one conclusion dominates all others: the major contribution of the independent college is to leaven the national educational scene with diversification and a source of innovative energy which lies beyond the capability of the public institutions. If the independent colleges do not really provide diversity, do not really provide a choice, but develop as privately financed carbon copies of the publicly managed institutions, then they will fail in the first important part of their mission; if they fail to innovate, they will fail in the second.

It is highly appropriate, and in fact necessary, for survival as an independent institution that Worcester Polytechnic Institute make a significant contribution in national educational leadership by providing an educational choice for students interested in scientifically - and technologically-oriented careers. Innovation is the essential ingredient in accomplishing this.

#### B. Conditions in the Status Quo to be Avoided.

From a study of the results of the April (1969) Planning Day, meetings with student living groups, and discussions with faculty it became obvious that there are some serious defects in matching WPI's educational effort to the needs of the students.

In common with many other technical schools, WPI's program developed from a discipline orientation and has evolved into a "course-work mill". That is,



the curriculum has been built around the notion that a degree in a particular discipline requires certain information and techniques. While there have been many attempts to modify this picture in recent years, the tendency for overlapping in the various disciplines has been largely ignored, resulting in course proliferation and duplication. Attempts to broaden the student by offering and even requiring courses in the humanities have largely failed, not only at WPI but elsewhere, because of the failure to show the students the relevance of their work in humanities to their professional careers. The result of these efforts is that the student finds his learning activities more or less "locked in" to a course program and satisfaction of his curiosity hampered by a formidable set of prerequisites.

A further factor of significance, as revealed by the living group visits, is the isolation of faculty from students. Here we do not speak of unavailability of faculty to answer student questions on technical material -- students are for the most part enthusiastic about WPI faculty in this respect. What is meant is isolation of the faculty as people who have a view of life, who practice what they preach, and who themselves are continuously learning.

The engineering students, particularly, find that they cannot relate their course work to their views of the practice of the profession. There is considerable repetition in the program. Students honestly admit that for the most part they are not putting forth their best efforts -- the program is just not worth that.

Finally, students find campus life devoid of interest. Intellectual interchange is the exception rather than the rule, and the very thing many of them hoped to find in college is missing.

One result of the above considerations is that the Committee has decided to relegate to an inferior position the argument that "our students have limited capability". This argument appears to be false and has so pervaded the thinking of both students and faculty that it has strongly affected the quality of WPI's present program.



C. Conclusions Based on Examination of the Twelve Possible Objectives for WPI.

Of the twelve possible objectives discussed in the first two progress reports, numbers 1 (High Quality Pre-Graduate Education), 2 (Educate for Leadership...), 3 (Classical Education), 5 (Middle College), 7 (...Educating the Underprivileged), and 8 (...Invention and Entrepreneurship) have some merit for a significant fraction of faculty and students with number 1 being the most popular. Relatively strong student support for the "General University" option and for adding a "Technological University" option seems to be based on a desire to facilitate shifting to a different major field rather than any particular enthusiasm for the kind of college implied per se.

Objective 3 (Classical Education) appears to be controversial in two respects. First, students were particularly attracted to the freedom implied but were quite honest in wondering if there would be sufficient motivation for doing the work. Second, the success of such a program depends a great deal on a tradition of scholarship, a life style, and a pre-college education not available to WPI or its students. Nonetheless, making the student responsible for his own education has a considerable appeal to both students and faculty. The flexibility of the program is also attractive.

D. Essential Considerations in Developing a New Program.

Apart from the obvious fact (see "A" above) that a private college which merely mimics the State University cannot justify a separate existence and will eventually die from lack of funds, the Committee feel that there are several overriding considerations which should determine WPI's goal and the implementation thereof.

1. It is hopeless to attempt to provide the student with enough information and technique to see him through a lifetime of professional work. Rather, it is far better to develop the student's learning capability so that he can learn what is necessary to solve the problem at hand -- to meet the unfamiliar situation competently.



2. It has become obvious that society is being well supplied with technologists who, given time and money, can eventually solve nearly any technological problem from development of an anti-polio vaccine to placing a man on the moon safely. However, decisions as to what technology shall be developed and what problems attacked are made by the lawyer, the sociologist, and the politician who are, for the most part, unaware of the nature of technology itself. While most thoughtful people recognize this, there is not now a single college-level program which has adequately come to grips with the challenge of developing and encouraging the necessary human understanding in its science and engineering students.
3. The strongest motivating factor in student learning is the student's own interest, misplaced as that may be. Any particular problem becomes interesting once it is recognized as relevant to the student's interest.
4. The essence of the college experience is the environment -- the nature of the community. There is no stronger motivation for intellectual development than the inspiration of one's associates. Delight in learning is infectious.

E. The Suggested Program.

The foregoing considerations led the Committee to conclude that a program based in large measure on projects and independent study has basic merit. Such a program would provide practice in learning to meet the problem at hand. By making some of the project work deal with the interface between technology and the society it seeks to serve, we could at once provide the motivation and the means for developing the "humane technologist" to whatever extent is possible. Further, with such a program the College would have an opportunity to develop the uniqueness needed for its survival, and the students would find themselves sharing a learning situation with the faculty.

In order to avoid the pitfall of unnecessary and possibly obsolete requirements, degree requirements should be restricted to the necessary and

sufficient condition that the student demonstrate his ability to learn. While the student should be allowed to specialize, maintenance of flexibility in the program and consistency with degree requirements indicates a Bachelor of Science degree without specification.

Courses must be offered in which the scattered experience gained from various kinds of project work is correlated into an integrated whole; this is a different type of course than the large majority of those now offered at the College.

Finally, the proposed program retains the possibility of execution of the attractive features of objectives 1, 2, 3, 5, 7, and 8 (see "C" above).



## II. THE EDUCATIONAL PROGRAM.

In this section the educational tools, proposed degree requirements, advisor set-up, and school calendar are discussed. Because a primary objective of the college should be to teach the student to learn, and because this process is highly individualistic, it seems advisable to have as little formal curricular structure as possible. The lack of structure has the virtue of providing at once the flexibility needed and the requirement that the student develop the self reliance characteristic of a truly educated person.

### A. Educational Tools.

#### 1. Projects and Independent Study.

Since it is a primary objective to "teach the student to learn" for himself, and since the successful project or independent study program requires learning those facts and techniques necessary to solution of problems, projects and independent study become a major educational tool. This device also has the potential of aiding in motivating the student because the relevance of the various library and course materials is made evident. Normally it is expected that the student will put a minimum of 25% of his load, averaged over a 4-year period into this part of the program. Projects will be of two principal types.

- (a) Research and development projects of the type common to most technical college research programs.
- (b) Humanistic-technological projects. Examples of these projects might be: the effect of a new north-south toll road on the people of central Massachusetts; the economic, technical, and social implications of a law restricting pollution of the Blackstone river; VISTA; and UNICEF. It is this type of involvement which is designed to bring the student to a familiarity with technology as a service to society, leading him to a sense of professionalism in the sense of assuming responsibility for some area of society's needs, and showing him the relevance of his studies of human behavior.

It is believed essential that a fair fraction of the projects be centered off-campus, in industry or in society at large, the College retaining control



on the acceptability of the problem. This belief is based on the need for emphasis on the reality of technological work.

## 2. Courses.

While the projects and independent study will provide motivation, practice in problem solving, and practice in learning, it seems essential that courses be offered to bring coherence to what has been learned in the projects. Further, some special kinds of instruction will have to be provided to lead the student from the curricular disciplines of the American secondary schools to the unstructured system proposed. It is, of course, hoped that the student will want to take some courses merely to satisfy his curiosity. It is expected, therefore, that three main types of courses will be offered.

- (a) Courses designed to supply preliminary information and a transition to WPI's unstructured system. These will hopefully be confined to the first two years. Considerable experimenting will be required in this area.
- (b) Short courses of the "how-to-do-it" type to aid in acquiring specific techniques as they are needed (Library usage, computer programming, report writing, graphics, shop practice). These might eventually be replaced by video tapes.
- (c) Summary courses. These would be of the lecture-supervision type. In these courses (offered especially to upperclassmen and certainly to graduate students) it is expected that the student is already familiar with the subject matter through contact in his project work and his own reading. The lecturer can, therefore, bring his own unifying and/or unique approaches to the material. Supervisors, meeting with four students at a time, can answer questions brought by the students and go over solutions to specific problems.

While it is the right of the instructor to assume that the student has done or is doing some ancillary reading, there will be no prerequisites required for registration for a course.



B. Degree Requirements.

The degree given will be Bachelor of Science. Students may "major" in a Study Group or Division Area. While it is believed that the College should not assume the obligation to educate the student but provide an atmosphere in which the student who so chooses can become educated, and while it is believed that the student should be allowed to follow his own best course toward that education, it is essential that the degree be awarded only to those students who have educated themselves. The following degree requirements are suggested:

1. Acceptable advanced-level work on two projects or independent study programs.

(a) It is strongly urged that at least one of the qualifying projects be of the humanistic-technological type.

(b) It is strongly urged that at least one of the qualifying projects be centered off-campus.

Advanced level work must produce a tangible result (usually in the form of a written report) which shall be judged not only for technical content but also for manner of presentation both by the project supervisor and external examiners. All results shall be subject to spot check external to the College. Grades will be assigned for all project work as follows:

A = Acceptable

AWD = Acceptable with Distinction

NA = Not Acceptable

2. A minimum residence of two years is suggested because of the importance of the environment to be established.

(It can be argued that with proper supervision in the project work, the above requirements will produce a better evaluation of the student's capability than has been possible heretofore, and that the above requirements provide a sufficient basis for awarding the diploma. It can also be argued that to ensure to ourselves and to the world at large that the program is achieving



its objectives, a further testing of the student's ability to learn on his own is desirable. For this latter case the additional requirements listed below are suggested.)

3. Examinations.

(a) A comprehensive examination in a division or study-group area.\*

This examination may include oral as well as written parts, should be of the "open-library" type, and must be the work of the student alone. Care must be exercised that it not be possible to "cram" for the examination. The student's efforts must not be oriented toward passing the examination. Comprehensive problems, research proposals, design problems, and comparative work are suggested possibilities. In any case the examination should confront the student with the unfamiliar.

(b) Two "sufficiency" examinations in areas other than that of the comprehensive, at least one of which should be in a different division from that of the comprehensive.

Grades for these examinations shall be A or AWD (an unsuccessful attempt is not recorded), and the examinations may be taken at any time after matriculation with the approval of the student's advisor. All examinations and grading thereof are subject to external review and on a spot check basis external to the college. Hopefully there will be contributions of examination questions from outside the College.

There are no formal course requirements for the degree, but there is some opinion that grades of A, AWD, or NA should be assigned to the course work and so recorded to give the student some indication of the quality of his work. The grades may be determined by any method the instructors develop.

One of the advantages of this set of degree requirements is that the instructor is removed as much as possible from the dual role of counsel and judge.

When the student has completed the above requirements, his advisor submits his name to the Academic Council\* for recommendation to the faculty, and thence

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\*See proposed Organization of the College.



to the Board of Trustees.

There is some concern that in spite of the high tuition cost some students who consistently fail to do acceptable work will not want to leave the College even when counselled to do so by their advisors. If such a thing should happen with enough students, there is the danger that a critical mass of inactive students might obtain and thus drag the performance of the entire student body downward. For this and other more obvious reasons it is suggested that the Academic Council be empowered to require that a student terminate his work at the College.

Physical education will play an important role in the overall development of the future students. While it is anticipated that physical education courses would not be required for graduation under the recommended program, all students, throughout all four years, would be urged to participate in physical education courses and intramural activities. The present general level of intercollegiate competition seems appropriate for the future. It is suggested that under the recommended program the physical education faculty be given a higher degree of responsibility in the counseling activities of the College.

C. Advisors.

The entering student is assigned to an advisor who sees the student through the program. It is the Council of Advisors, by virtue of their familiarity with student needs, who determine what kinds of projects are needed and what courses should be offered.

Because of the unstructured nature of the program it is essential that the student records be computerized so that the advisors can have at hand all information for counseling the student. Obviously, the project supervisor may have the best and closest contact with the student and can give considerable assistance to the advisor.

The exact relationship of the student to his advisor will depend in large measure on the student living group structure.\*

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\* See "Co-ordination of College Community Life with Academic Purpose..."



D. The School Year.

Tentatively it is suggested that the school year be divided into four eight-week terms. This would provide flexibility in course offerings, project-logistics, and scheduling. The student would carry four units of work each term. Courses may extend for from one to four terms, depending on the objectives. There would also be an optional eight-week summer term.

A typical school-year calendar might be:

29 September - 22 November	First term
1 week vacation	
1 December - 19 December	
2 weeks vacation	
5 January - 6 February	Second term
1 week vacation	
16 February - 11 April	Third term
1 week vacation	
20 April - 12 June	Fourth term
1 week vacation	
22 June - 15 August	Summer term

### III. ORGANIZATION OF THE COLLEGE.

For purposes of executing the proposed program, it seems advisable to undertake a considerable revision of the organizational structure of the College. There are several suggested key concepts which are shown in Figure 1. Many of the details shown in the figure should be regarded as tentative and open to discussion. Some of the key concepts are discussed below.

A. Program Development and Evaluation. This group is designed to replace the Planning Committee with the additional responsibility of evaluating the entire program of the College against the stated goals. The group reports directly to the President and consists of faculty members, including administrative officers of faculty status, and students. (It is suggested that there be four members elected by the faculty, one member appointed by the President, and one student. The chairman should be selected from among the elected faculty.) Aiding this group is a Visiting Committee and Board of Examiners made up of people from outside the College, representing industry, education, and government.

B. Two Vice-presidents are suggested. The Vice-president for Logistics and External Affairs is responsible for the fiscal operation of the College, both in terms of raising funds and in terms of expenditures, for maintenance of the physical plant, for public relations, and for development of non-faculty personnel. The Academic Vice-president, working with the Academic Council (see below) is responsible for the academic operations of the College.

C. The Academic Council. This group consists of four elected faculty, one appointed faculty, and two students. (Administrative officers of faculty status are considered eligible.) The chairman should be selected from among the elected faculty. The Academic Council is responsible for the academic program of the College, maintenance of standards, implementation of programs, overseeing of admissions policy, student life, and co-ordination of the work of the Council of Advisors (see below) with the Deans of Program Operations and Academic Resources.







D. The Council of Advisors, consisting of 6 - 8 selected advisors, bears the main responsibility for communicating the academic and social needs of the students to the Academic Council and the two Deans (see below). Because the needs for projects and courses of various kinds have to be matched with the capabilities of the College, and since it is this group who have the primary input from the students, the College's specific operations start in the Council of Advisors. The executive officer of the Council shall be known as the Registrar.

E. The Dean of Program Operations is responsible for the project and independent study operations of the College. Through his two Co-ordinators the Research and Development and Humanistic-Technological projects are administered. The Field and Campus Administrators take care of purely logistical matters such as liability insurance, transportation, quartering of project personnel, and of financing and maintaining adequate laboratory supplies and equipment. Program operations are staffed from the Study Groups through co-operation with the Dean of Academic Resources.

F. The Dean of Academic Resources is responsible for the development and maintenance of the academic resources of the College, including courses, services (consortium instruction, computation facilities, library), and faculty personnel.

A separate discussion of the professional organization of the faculty is in order. A proper environment requires extensive faculty-faculty interchange, so there must be faculty groupings. Because of the problem orientation of the program and the increasing overlap of the various traditional disciplines, it seems wise at this point to abandon the departmental structure of the faculty and to regroup into common areas of study - Study Groups. It is not to be inferred that there need be any permanence to a Study Group, for in the course of time it will be necessary to dissolve some and establish others. The Dean of Academic Resources must bear the ultimate responsibility for seeing that the Study Groups remain relevant. Some suggested Study Groups are shown in Figure 1, but these are subject to considerable revision. It is important to recognize that the common denominator in the Study Groups is the problem orientation rather than the academic background of the members. The Study Groups are collected



into three Divisions. Each Study Group Division has a chairman, selected for his professional leadership. The Division Chairmen, in co-operation with the Dean of Academic Resources, are responsible for personnel development of the faculty (including promotion and salary determination) and for determining what courses are to be offered and by whom after consideration of information supplied by the Council of Advisors. Large Study Groups may also select a chairman. Administrative details (work loads, salary allocation, office space) are handled by administrative assistants.

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#### IV. CO-ORDINATION OF COLLEGE COMMUNITY LIFE WITH ACADEMIC PURPOSE OF THE COLLEGE.

An undergraduate student is not educated in classrooms. He gathers knowledge there; he learns techniques there; and hopefully he finds teachers there who provide him with high standards of achievement; but he decides elsewhere how he will use this material and what his own standards and attitudes will be. What his former community and family thought important, what his campus peers think important, and what attitudes are generally prevalent and practiced by the total campus community are influential educating factors in his life.

Even if a college makes no attempt to co-ordinate its community life with its academic goal, the attitudes on campus concerning the purposes of learning will still have a marked effect on whether or not the college achieves its stated educational objectives. If the majority of the students believe the purpose of the bachelor's degree is to secure affluence for the holder, the college will probably have difficulty promoting different ideals. If the student social life is vulgar, the college as a whole will tend toward vulgarity. If the faculty isolates itself from the student community, the influence of the college on student attitudes will be reduced. If dining facilities are run like downtown cafeterias or military mess halls, the college must accept the effects upon its academic goal.

Student life and interaction among students, then, has as important an influence upon the educational effectiveness of the college as does the formal structured academic program, but the interaction among faculty has an equally important effect. When a college is analyzing its potentialities, it needs to ask some courageous questions about the commitment of its faculty. Is the college a corporation where one works from nine to five and must attend an occasional extra event, or is it a special community whose success depends on the intellectual and social interaction among its members? If it is the former, the college should in no way make social demands on its employees; if it is the latter, the college will want to help secure housing in the local community and will wish to provide possibilities for a good faculty club and for places on campus where students and faculty may meet together.



### The Questions of Tactics.

Rather than attempt to proceed with a design for a utopian campus which would foster the general goal of educating the humanist engineer, it seems wiser to raise some basic questions which both faculty and students might now want to consider about our life together. The first three of these questions are basic; the second group of four are more specific.

### Three Basic Questions about the WPI Community.

1. Do students and faculty wish a community here in which there is interaction outside the classroom among the students and faculty? If "yes," what kind of interaction? If "no," why not?
2. To what extent should the college serve in loco parentis, guiding the student in his behavior, particularly in matters of alcohol, narcotics, sex, and use of property?
3. What social, cultural and intellectual activities should the college encourage, to what extent, and for what purpose?

### Four Specific Tactical Questions.

1. On a campus how does one protect both individuality and the sense of community?
2. How does one develop potential leadership?
3. When is a college intellectually exciting?
4. How could WPI assure that its graduates will have a broad and mature understanding of human behavior and values?

### Some Possible Student Living Arrangements

- Case I To Recognize Student Maturity by Delegating to the Students all Responsibility for Living Arrangements.
- Case II To Provide Housing on a Rental Basis With the College Assuming Landlord Functions Only.
- Case III To Utilize Small Housing Units.
- Case IV To Utilize Residential Colleges.
- Case V To Foster a Strong College-Oriented Fraternity Living Unit System.



- Case VI To Organize Student Living in Large Dormitories.
- Case VII To Franchise Dormitory Operation to a Professional Hotel Management Organization.
- Case VIII To Develop Student Maturity by Establishing Separate Living-Educational Quarters for Seniors.
- Case IX To Maintain the Status Quo.
- Case X An Appropriate Combination of the Above.

#### Case I

To Recognize Student Maturity by Delegating to the Students all Responsibility for Living Arrangements.

Today's undergraduates are used to a much greater degree of responsibility and freedom than those of previous generations. In many instances they have, prior to their matriculation, exercised this responsibility by living away from home for short periods or for an entire summer. This may have taken the form of traveling or living away because of job requirements.

For these reasons, current undergraduates desire to live in accommodations of their own choosing and the traditional college role of providing not only housing but a degree of control is no longer advisable.

Under this proposal, the college might provide assistance in the location of housing; however, primary responsibility would rest with the student. He would be considered an adult, insofar as the law permits, and assume his own civil responsibilities.

#### Case II

To Provide Housing on a Rental Basis with the College Assuming Landlord Functions Only.

This case rests upon the student maturation characteristics as presented in Case I. Because there may, from time to time, be difficulty in



the location of off-campus housing, it is proposed that the college purchase such housing, making it available to students on a rental basis. The relationship between the student and the college in this case would be the same as the relationship between an owner-landlord and tenant.

With respect to responsibility and freedom, the student would continue to exercise all rights under law as applicable to the landlord-tenant relationship. With respect to student conduct, the college would not provide an interface between him and civil authorities.

### Case III

#### To Utilize Small Housing Units.

In this case, the college would provide small housing units with dining and sleeping accommodations for 75-125 students. The college would assume normal hotel functions, such as food preparation, furnishings, and service. Faculty and administrative staff members would be associated with each House Unit, taking occasional meals and participating in some appropriate programs, both social and cultural.

The ideal, in this case, would be an intellectual and social melding of the campus community, cutting across college-class and disciplinary lines. This arrangement would create an opportunity for frequent exchange of ideas by all associated with the unit and provide a small enough group for the formation of lasting friendships.

### Case IV

#### To Utilize Residential Colleges.

This case envisages a living system somewhat similar to that of Case III, but enlarged in numbers. Each residential college might total 200-250 students. Faculty and administrative staff would be associated with each unit. They would take occasional meals and participate in the social-cultural life of the college.

The major distinction between this case and that of Case III (House Units) is that, because of the increased size, there would be more diversity in the



members' interest patterns but ample opportunity for the formation of sub-group friendships.

#### Case V

##### To Foster a Strong College-Oriented Fraternity Living Unit System.

In its ideal form, this system reinforces the educational role of the college yet provides for living groups of common interest patterns. Further, it does serve an educational role in leadership development as it carries out its self-management functions. The criticism that this system discriminates per se is somewhat time-worn in this day of student egalitarianism.

This case should not be confused with the status quo (Case IX). There would appear to be sufficient criticism of some of the current WPI fraternities to question seriously whether they are in fact fraternities or self-governing hotels.

#### Case VI

##### To Organize Student Living in Large Dormitories.

Utilizing existing dormitories and new ones yet to be constructed, this program would involve a system similar to that presently afforded to freshmen. Appropriate changes would seem necessary in the dining hall patterns along with the addition of informal lounges on each floor. Present college regulations involving student life-styles would also need study. The formal involvement of faculty-advisors and supervisors in the cultural-social programs of each dorm could be considered.

#### Case VII

##### To Franchise Living Operations to a Professional Hotel Management Organization.

The major distinction of this option is that a student-formed corporation,



the college, or a joint corporation would lease the operation of the living units to professional hotel-type management. This could provide excellent facilities and services and allow the college to concentrate on the academic program.

#### Case VIII

##### To Develop Student Maturity by Establishing Separate Living-Educational Quarters for Seniors.

It is well known that as a student nears graduation his interest patterns change. This system recognizes such change and affords seniors a special setting in which they may develop their activities in a manner they deem appropriate. Presumably, the faculty would be involved in this structure. A nearby example of this case is that of the Senior Center at Bowdoin College.

#### Case IX

##### To Maintain the Status Quo.

No discussion is attempted here.

#### Case X

##### An Appropriate Combination of the Above.

No discussion is attempted here.



## V. THE LOGISTICS OF PROJECTS AND INDEPENDENT STUDY.

### A. Introduction.

Implementation of the concept that each student at Worcester Polytechnic Institute will have a minimum average commitment of approximately 25% of his time in individual involvement through project work, independent study and field work will require the development of new techniques, new facilities, and, above all, new attitudes.

Worcester Polytechnic Institute cannot be unique and remain the same; it cannot experiment in a significant manner with the educational process and remain the same; it cannot increase student involvement and keep the same academic regulations.

In considering the logistics of involvement, no single resource is as important as the faculty. Under the recommended plan the individual faculty member, largely free from the framework of an elaborate impersonal quality point system and the canons of "Regulations for Students", will assume far greater personal responsibility for the development of each student with whom he has contact. The professional competence and teaching interest of each faculty member will be placed in a bright light, since as a worker himself he will be constantly learning, meeting new situations, and at the same time guiding the development of his students. Whether directing independent study, developing undergraduate research, leading a technical project, or studying a governmental problem, the faculty will assume the role of learners and doers themselves. This development will bring into sharp focus an issue often discussed but usually obscured by an elaborate shroud of academic infrastructure: the standards of a college are really the standards of the individual faculty members.

### B. The Program Structure.

Since experience alone can determine the ultimate structure of the program, it is possible to develop the model based only upon the experience of relatively small undertakings of this type, both here and on other campuses.

Drawing upon experience gained here and on other campuses, four general



types of activity for the WPI program can be envisioned:

TYPE A: Individual Work.

Individual study and research; directed field work; domestic and foreign programs--VITA, UNESCO, exchange programs.

TYPE B: Individual Team Projects.

Three-man units, on the average, undertaking a large range of activity from ES 102-type projects through senior level industrial projects and research.

TYPE C: Comprehensive Project Activities.

Two sub-units of three to four students each, working in areas which may combine upperclassmen leaders with underclassmen in a supporting role, or combinations of technical and humanistic efforts.

TYPE D: Systems Project Divisions.

Basic groups of fifteen, including those from a variety of levels and study interests. These groups would be core divisions of study efforts in environment, computer simulation, robotics, system design and prototype development. It is expected that many projects undertaken in this area would receive outside support.

Experience with existing project work indicates that a three-man group forms a satisfactory working unit. One member, serving as leader, coordinates the work of the group. Since a professor can follow the work of fifteen students at most, no faculty member should supervise more than five three-man units.

Type C activities, for example, would normally require two three-man units with an "activity leader" being the seventh member of the team, unit leaders and activity leaders would assist the professor in evaluating the contributions of the unit members. It is expected that graduate assistants would play an important role as both Type C activity leaders and assistant division directors, both in assorted five-team groupings and in Type D programs. Active responsibility will substantially enhance the educational experience of graduate assistants, especially in the engineering programs.



The following is a probable initial distribution model for the activity classifications listed above (assuming 2/3 of students involved in on-campus projects).

<u>ACTIVITY TYPE</u>	<u>STUDENTS PER UNIT</u>	<u>NUMBER OF UNITS</u>	<u>TOTAL NUMBER OF STUDENTS</u>	<u>% OF STUDENT BODY 2000 Base</u>
A	1	300	300	15%
B	3	150	450	23%
C	7-8	40	285	14%
D	15	<u>20</u>	<u>300</u>	<u>15%</u>
		510	1335	67%

The logistical figures given in this section and the subsequent one are nothing more than reasonable projections. The proposed program is sufficiently flexible to allow considerable deviation from these tentative distributions. For instance, up to two thirds of the student body could be easily accommodated in project work during any given year. The critical parameter is the figure of fifteen students per full-time supervisor.

Many faculty members, actively involved with projects, would still be teaching their specialties by acting as consultants to workers in other projects.

In the preceding paragraphs only full-time faculty have been considered. It is expected that the faculty, as leaders and consultants in the program, will have the status of professionals and will be supported in project development by graduate students, upperclass project leaders, off-campus experts, and paraprofessional staff in technical and logistical support.

Under this type of organization, seniors and graduate students will have a real operational responsibility, an experience almost totally lacking in our existing programs. Furthermore, there will be a substantial reduction in the barrier between ivory tower and community, with qualified leaders from outside participating actively on the campus and with WPI students meeting people and situations off the campus.



C. The Role of the Faculty in the Program.

The successful promulgation of the proposed program will depend to a considerable extent upon faculty capabilities and interests. A discussion of a possible distribution of faculty participation, involving the undergraduate program only, appears below. This distribution is based upon the assumption that there is an undergraduate enrollment of approximately 2000 students.

In section B above, there appears an initial distribution model of student project activity. A corresponding model of faculty activity can be derived by considering the student model from the faculty point of view. There are three essential considerations: (1) during any given term, some 2/3 of the student body should be involved in on-campus projects; (2) a full-time faculty member could be expected to direct the work of 15 students on projects; (3) a 15:1 student-faculty ratio is academically feasible and economically desirable. Thus, during any given term, there would be approximately 1,333 students in projects on the campus and a need for 133 full-time equivalent faculty involved in the undergraduate program.

On the basis of these figures, the model appearing in the table below represents an initial distribution of faculty participation, recognizing the varied interests of the faculty and the consequent degrees of involvement in the project work:

<u>Number of Faculty for each Type of Participation</u>	<u>Number of Students on Projects for each Faculty Member</u>	<u>Total Number of Students Involved</u>	<u>Number of Course Secs. Taught by each Faculty Member</u>	<u>Total Number of Course Sections</u>
15	15	225	1	15
60	12	720	1	60
30	9	270	2	60
20	6	120	3 (1 dupli.)	60
<u>10</u>	0	<u>0</u>	4 (1 dupli.)	<u>40</u>
135		1335		235

At this point, it is well to compare the requirements of the model with the realities of our present program. During the academic year 1968-69 the average number of course sections per term was 358.\* It is clear, therefore, that this figure must be reduced. A substantial saving in faculty time as well as cost can be effected by employing greater use of the lecture method to

\*Does not include seminars, research projects, independent study, physical education, military science, or the evening program.



large student groups, utilizing graduate students and, in a few instances, selected upperclassmen to handle tutorial sessions. An additional saving can be accomplished by the consolidation of a number of existing courses, each covering essentially the same topics but taught by a number of different departments. The latter reduction would, of course, be a natural consequence of the suggested revisions in the organizational structure of the College. Finally, some of the semester courses could be replaced efficiently by independent study, student-operated seminars, or restructured eight week one-term courses. For example, the course offerings of the last academic year (see above) could have been reduced to approximately 157 sections for the first semester and 179 sections for the second semester, including 70 and 104 one-section courses, respectively. In no instance would more than 100 students have been grouped into a single lecture section.

There is also some question regarding the capability of the individual faculty member to supervise projects involving as many as fifteen students effectively. To some extent, this is a matter of the individual concerned and the nature of the projects under his direction. For this reason, the bulk of those involved with projects would be working with fewer than fifteen students, since it is essential that no faculty member be overloaded in this way. An excessive student load would impair the supervisor's effectiveness and could well lead to general superficiality in his projects. It is important to remember that each faculty member would receive some assistance in planning for and obtaining projects through the staff of the Dean of Program Operations and that his own load would be regularly and carefully reviewed to avoid the over-utilization of his talents.

WPI is fortunate in having a sufficient number of well-qualified faculty to make the above model realistic. A brief review of the current staff has convinced the Planning Committee that even on a minimal basis, there are enough faculty to support each category within the model. It would be our suggestion, however, that the College appoint some ten additional faculty, chosen primarily for their ability to generate and supervise major projects. This addition would permit adequate rotation of those involved with such projects, an important consideration for the long-term continuation of the program. Since the



initial stages of the proposal are of such critical importance, it is suggested that these additional staff appointments be made as soon as possible in order to provide a substantial reservoir of highly qualified personnel to generate the first major projects.

It is our belief that each faculty member, regardless of his commitment to the project phase of the program, should teach at least one course for at least two of the four eight-week terms during the academic year. The reasons for this stipulation are two-fold: first, the faculty member actively involved with project work is in a learning situation, and it would be helpful if he could impart his attitudes and thoughts to a wider group of students than he might be supervising; second, his classroom efforts should assist him in maintaining a proper objectivity about the entire academic program and will force him to remain current with developments in his specialty. Clearly, those with little or no participation in some form of project work or research must assume a fairly heavy teaching load.

The model does not include specific allocation of faculty time for advising. Good teachers, by the very nature of their interest in their subject and students, are constantly involved in informal yet meaningful advising; there is no reason to expect that such would not continue to be the case. Since the emphasis of the program is to create an atmosphere of self-education with a minimum amount of formal structure, the role of the advisor is considerably altered. He is no longer either a taskmaster or a policeman but rather a more experienced co-worker who suggests possible alternatives for the student to pursue. Within this context, it is assumed that specific time allocated by the faculty for advising will be relatively minimal and far less frustrating than at present. Much of the advising will be the natural by-product of participation in independent study, seminars, and projects; some will come from older students further along in their studies; some will also come from those faculty teaching formal courses; and the remainder will develop through the dialogue between the student and his appointed advisor or between him and those faculty to whom he is referred by that advisor.



As the proposed program reaches full operation, there will undoubtedly be perturbations on the suggested model. The organizational structure visualized would permit necessary changes to occur with as little disruption as possible. No faculty member would regard his participation as permanently categorized. Indeed, he might vary his activities from year to year, not only to satisfy the demands of the total program but also to provide flexibility for his own personal and professional development.

D. Space Requirements.

With a major emphasis on project and seminar activities at all student levels, the space requirements of the College will be significantly altered. It will be essential that project groups have exclusive access to some type of work and office space to carry out their activities. They will need these areas to meet together, to work, and to store their project materials. Much of the student's intellectual growth will be sparked by these projects and seminars, and a private "home base" for the teams is very important for educational stimulation.

Fortunately one of the College's present major strengths is its physical plant. At present there is a large amount of little used space that could be adapted for project work or offices. The instructional laboratory space on the campus is being utilized on the average only 23 percent of the available time. This figure is exclusive of research laboratories.

Approximately 64 percent of the total of about 124,000 square feet of instructional space on the campus is used for laboratory. This space potential places WPI in an enviable position for major project and seminar activities. There are ample areas available that can be modified as required. Indeed, this program will remedy an embarrassingly low utilization factor. Some buildings such as Atwater Kent already have many fairly small cubicle arrangements that would be ideal for project office space. There is a large amount of uncommitted space available for remodeling: for example, the top floors of Salisbury Laboratories and the Washburn Shops are both empty.

The classroom activities of the College will also undergo major changes



under the proposed program. It is conjectured that there would be a large percentage increase in small size seminar courses. Coupled with this, on the other hand, there would be increased demand for large lecture courses. Under these constraints, the College classroom space capability is limited. Many WPI classrooms are of the twenty-five to thirty-five student size with rather few large lecture halls and few available seminar rooms. There are, however, many inexpensive methods of subdividing existing medium size classrooms into smaller units. As more detailed studies of the program progress, the number of basic formal course offerings required will set the demands for large lecture halls. The committee cannot at present determine if this factor is critical. There would be a tendency for less fragmentation of courses. For example, probably only one campus-wide basic course offering in fluid mechanics would be necessary. This reasoning could be applied to many different disciplines, and it could increase the demand for large rooms. On the other hand, the classroom utilization factor at the College is at present so low that an increased number of large classes might be easily accommodated. It is also true that this program will significantly reduce the total number of formal courses.

#### E. Technical Services.

The proposed program will change the technical service needs of the campus. Projects dealing with real problems will require first, an ample supply of modern instrumentation and, second, a staff of technicians and machinists to support the projects. These needs will foster the establishment of a central purchasing department and stock and instrument-room facilities. WPI already has technical personnel to support its present research and educational activities. With two to three hundred project activities in operation, however, this staff would have to be increased. Probably the most critical shortage initially would be adequate numbers of electronic instrumentation specialists.

Under the new curriculum, the students would have much more opportunity and need to undertake some of their own fabrication and testing in connection with project concerns. WPI would have to develop a student shop function



where students could do their own experimental work. This means that supervisory personnel and clerks would be required to staff these facilities during rather extensive daily hours--much as a library service. In qualifying students to use these facilities, much use could be made of tape libraries, film, and filmstrips for information passage. For example, the basic operation of cathode ray oscilloscopes could be taped for hands-on use by the student. This type of student laboratory-shop facility does not exist to any extent here now, and its development represents a considerable effort. However, its initiation strongly supports the Two-Tower tradition, and laboratory and shop facilities available and open for student use are vital to the program in addition to facilities manned and operated by professional technicians. WPI has a large supply of shop equipment already available but little used at present which can be used for this purpose. Indeed, a recent case of students breaking into a machine shop to use the equipment is a painful example of the wrong but prevailing attitude.

Finally when students and faculty are involved in projects, there will be extensive interaction with the project sponsor. The College will have to support insurance liability in conjunction with these activities. The reluctance of the College to accept this responsibility in the modest student project efforts presently conducted at WPI has hampered the development of this activity.

It is anticipated that the sponsoring organizations will supply significant technical services to support the College activity. This would decrease the burden for development of these services by the College.

#### F. Project Development.

The sources of project activity are many and varied. Many projects will spring from faculty interests that are unsponsored but provide significant educational experience. The present activities of ES-102 fall within this category. Other faculty-sponsored research will provide experience for all levels of students. The Alden Laboratory will find increased technical support from faculty and students. The Worcester Foundation for Experimental Biology represents a potential major source of project work. Government agencies,



municipal, state and federal, will provide important source areas. For example, the state of New Jersey already has operating an internship program for college students to work actively in state socio-technical problems at a decision making level.

G. Organizing the New Program.

Once the program described in the preceding pages is in operation, one idea will produce another, one project will lead to several, and a reputation for action will radiate. There is, however, an obvious and breathtaking chasm between the current educational operations of Worcester Polytechnic Institute and those outlined in this plan. To succeed, the program must be brought into operation in as short a time as possible. There will be little hope of significant achievement if projects and independent research and study are reluctantly tolerated as ancillary activities. They must form the core of the student's educational experience at the college.

It is anticipated that a three-year development period will be necessary to prepare for full commitment to the program. The phases of the development period would be as follows:

First Year: Organization of the development group  
 Acquisition of funding  
 Recruitment of additional members of the group  
 Pilot program development  
 Task identification for second year implementation

Second Year: Activity development  
 Resource development  
 Selective pilot program operation  
 (In the "pilot program" it is proposed that the full concept of the program including the new degree requirements be implemented for a small number of selected students. Students from all classes would be invited to apply for enrollment in the pilot program. The purpose of the pilot years would be to gain experience in handling the program and set up mechanisms to provide smooth flow of communications.)



Third Year: Enlarged pilot operation at all levels  
Completion of activity and resource development

Fourth Year: Full operation

Were, for example, the program development to start during 1970, the freshmen of 1974 would be the first to enter with the program in full operation.

Activity Development should include the following tasks:

- (a) Field Program Liaison (VITA, UNESCO, VISTA, Peace Corps, Internships, Foreign and Domestic Exchange Programs).
- (b) Development of Industrial Projects.
- (c) Government-Oriented Activities, Technical (NASA, NSF, NIH).
- (d) Government-Oriented Activities, Socio-Humanistic (State, Federal, Local).
- (e) Development of On-Campus Faculty-sponsored Projects and Research.
- (f) Development of Independent Study Activities.

Academic Resource Development should include the following:

- (a) Development of New One-Unit (two month) courses.
- (b) Development of Seminar Programs with short, state-of-the-art presentations by invited lecturers, special workshops on specific subjects, and cultural programs, both on and off campus.
- (c) Development of Educational Aids, including TV and Audio tapes for self-learning of routine but essential background material in a wide variety of areas.
- (d) Consolidation of traditional course material in new "Study Group" structure, and formation of that structure.
- (e) Reorganization of classroom and laboratory space to meet new requirements, such as provision for many concurrent project activities.



- (f) Development of supporting staff of technical and clerical personnel.
- (g) Study of operational problems (experimental supervision, stock room control, purchasing methods, patent rights, proprietary information, legal constraints and liabilities).

To implement the program, it will be necessary to establish a task force whose primary responsibility is to carry out the work outlined above. A study of the tasks to be performed indicates that various levels of activity are appropriate to the three phases of development.

During the first year the effort will be directed towards planning with primary concern for recruiting the next year's members of the task force and of planning with precision the tasks that must be performed by the individuals during the intensive second year. It is proposed that the initial group contain five members.

During the second year the initial group would be augmented by five members, most of whom would be personnel on a year's leave of absence from industry, government or other colleges.

During the third year there would be expanded pilot program operation and conclusion of the major development effort. At this time the permanent operational personnel would start phasing into the program. During this year the number committed to program development full-time could again be reduced to five.

Since the development effort must be undertaken in addition to maintaining on-going programs, an incremental personnel cost will be incurred during the three-year development period. These expenses, based upon salary costs with approximately 90% overhead appear to be as follows:

FIRST YEAR	5 men	\$150,000
SECOND YEAR	10 men	250,000
THIRD YEAR	5 men	<u>150,000</u>
	Total:	\$550,000

There will also be initial costs involved in certain physical plant conversions in uncommitted spaces and laboratory areas.



## VI. FURTHER DEVELOPMENT OF THE MODEL (Where Do We Go From Here?)

A proposed model for WPI is presented in this report in outline form. It is important that at this point the entire College understand how far we have come in the Planning Program (cf. "The Future of Two Towers", pp. 4-5) and what must be done before the College can commit itself to the new program.

There remains the problem of supplying, between now and 1 December 1969, enough detailed analysis of the proposed model so that every member of the WPI community can fully understand and evaluate it, can be sure it is valid in terms of carrying out the philosophy and stated goal, and can see his own role in the program. In addition, a detailed costing of the proposed operation and of its implementation is essential.

At this time the Planning Committee suggest ten different areas which require intensive study.

1. College Environment and Student Life
2. Financing and Cost Estimation
3. Organizational Structure of the College
  - a. Job descriptions and staffing of the various components
  - b. Selection and organization of faculty study groups
  - c. The constitution of the faculty as a deliberating body
4. Courses
  - a. Transition courses
  - b. Short courses of the "how-to-do-it" type
  - c. Summary courses and scheduling
5. Examinations, comprehensive and sufficiency
6. Details of Advising Procedures
7. The Graduate Program
8. Implementation of the New Program
9. Development of Program Support
10. Evaluation of Inputs from the WPI community

The remainder of this section outlines, briefly, the work to be done in each area, suggests appropriate staffing, and indicates an action which will allow the work to proceed.



## 1. College Environment and Student Life

This area is of at least as much importance as the educational program outlined in the model as presented herein. The Planning Committee believe firmly that development of this area requires extensive input and effort by the students themselves, and, therefore, the problem was set aside until the students returned to the campus in the fall of 1969. The present report does contain a set of suggested forms and some questions to be considered. It is now proposed that full development of this most important area be delegated to a special sub-committee consisting of:

4 students

2 members of the office of student affairs

2 faculty

1 member of the Planning Committee (serving as chairman)

It is expected that this sub-committee will consider inputs from the entire community and will enlist the aid of additional students as needed. A complete model and its implementation is required.

## 2. Financing and Cost Estimation

While the preliminary cost analysis shows that the proposed program is financially feasible, it is necessary that a detailed financial picture be available. It is imperative that costing be done with two considerations in mind. First, cost estimates should be presented on staff and facilities necessary both for an optimum program and for a minimal program. These costs should not be computed as increments on the present program or extrapolations of the present cost estimating formulae; the proposed program is not like the present one. Second, it is essential in drawing comparative costs between the present and proposed models that the proposed program not be penalized by present inadequacies. (For example, faculty currently involved in experimental work spend a large fraction of their time acting as technicians and secretaries. The new program adequately staffed in these areas should only be compared with the present program adequately staffed by the same criteria. Inadequacies in the current library collection are a second example, and the model will clearly influence priorities.)



The task of preparing this total financial analysis should be assigned to a sub-committee consisting of:

- 1 Head of Department
- 3 faculty
- 1 member from Business Office
- 1 member from Dean of Faculty's Office
- 1 student
- 1 member from the Planning Committee (serving as chairman)

### 3. Organizational Structure of the College

This report contains a suggested organizational structure of the College (Section III), and some key items are discussed. It is essential that duties, staffing, and responsibilities of the components be clearly defined, and the structure must be carefully reviewed for its workability and modified as necessary. For this task the following sub-committee is suggested:

- 2 faculty
- 1 student
- 1 Head of Department
- 1 member of the President's staff
- 1 member of the Planning Committee (serving as chairman)

As part of this work the proposed faculty study groups and divisions need special attention. It is suggested that the committee develop a set of study groups and submit them to the faculty with a request that each member indicate his primary and secondary choices from the set augmented by any other groups he believes relevant. This committee should develop proposals for the study group divisions, their organization, and staffing. In this latter connection the Planning Committee believe that scholarship should be a prime consideration in selecting leadership and that purely administrative functions should be handled by administrative assistants.

The structure of the faculty as a deliberating body is already under study by the faculty-elected Faculty Constitution Committee.

### 4. Courses

The three types of courses suggested in Section II-A of this report need to be studied in detail and possible scheduling considered. Special attention



will have to be given to the courses designed to provide a transition from the structured curricula of most secondary schools to the unstructured program of the model. Suggested course offerings, duration, and mode of presentation should be developed.

This task could be assigned to a sub-committee of the existing Curriculum Study Committee.

#### 5. Examinations, Comprehensive and Sufficiency

The nature, need, and advisability of the comprehensive and sufficiency examinations require careful consideration. In particular, examples of each type of examination should be developed so that a complete and understandable specification of the degree requirements stands out. This task could be assigned to a sub-committee consisting of:

- 2 students
- 3 faculty (one of whom serves as chairman)
- 1 member from Office of Student Affairs

#### 6. Details of Advising Procedures

It is impossible to over-estimate the importance of the advisors and the Council of Advisors in the proposed model. It is also important that each member of the WPI community have a clear picture of what happens to the student who enters the College for the first time. It is, therefore, essential that the duties of and the information needed by the advisor and the Council of Advisors be established. In this task a sub-committee should be appointed consisting of:

- 3 faculty
- 3 students
- 1 member from the Office of Student Affairs

#### 7. The Graduate Program

The present report makes no attempt to analyze possible graduate programs, but it is clear that a graduate program would not only enhance the proposed undergraduate program but is essential for its success. It therefore is important that a description, standards, and costing of a graduate program be developed at an early date. It is suggested that this task be assigned to a sub-committee consisting of:



2 faculty (chosen for their participation in the present graduate program in interdisciplinary areas)

1 faculty member (serving as chairman)

2 graduate students

#### 8. Implementation of the New Program

Some discussion of the implementation of the new program is given in Section V of the present report. It is necessary that this be considerably amplified. The nature and extent of a pilot-program, the point and mode of transition from the present organization to the new one, and the details of how the total program will be phased in must be specified. For this task, a sub-committee should be appointed consisting of:

3 faculty

2 students

1 Head of Department

1 member of the Planning Committee (serving as chairman)

This committee should also examine needs for modifications to facilities.

#### 9. Development of Program Support

The proposed program will require extensive support in terms of off-campus projects with industry and government. In its optimum form, the program will also require additional financial support. Exploration of these areas could be assigned to a sub-committee consisting of:

2 faculty

2 alumni

1 member of Development Office Staff

1 member from Director of Research staff (serving as chairman)

#### 10. Evaluation of Inputs from the Members of the WPI Community

It is not unreasonable to expect that many comments requiring modifications and clarification of the model will be received. It is entirely possible that the Planning Committee, in spite of its efforts to examine the positive aspects of every suggestion, has overlooked a better possibility than that proposed herein. The Planning Committee should continue to receive and evaluate all criticisms and comments.



In order to implement the further actions discussed above and to staff the various sub-committees, the Planning Committee request that interested members of the faculty, student body, and administration volunteer in writing to the Committee before 8 October 1969.



## ACKNOWLEDGMENTS

The Planning Committee would like to acknowledge the many fine contributions it has received, in preparing this report, from members of the faculty, administrative staff and student body. The oral and written assistance of the following colleagues is especially appreciated:

A. Anderson, W. Barrett, C. Feldman, G. Hazzard, C. Koontz, D. Lloyd, M. L. Price, W. Roadstrum, R. Seaberg, and S. Weininger.

We are indebted to Mrs. Marion Mundy for her always careful secretarial support.



APPENDIX

ESTIMATED COST OF PROGRAM



## A: Estimated Operating Costs.

An attempt has been made to estimate the steady-state operating cost of the proposed program by adjustment of the expense items in the 30 June, 1969 Audit Report for the College. While it is recognized that this could lead to error, and that some items which must be changed cannot be easily estimated, the Committee believe that the resulting estimate is useful in evaluating the financial feasibility of the program.

From the 30 June, 1969 Audit Report (hereinafter called "Audit Report"), the College's Revenues and Expenditures are given as follows\*:

	Revenues	Expenditures	Net
1. Education and General	\$4,511,000	\$4,654,000	(\$143,000)
2. Auxiliary Operations	937,000	855,000	83,000(1)
3. Other Educational Operations	172,000	165,000	7,000
4. Student Aid	567,000	567,000	—
5. Alden Research Laboratories	1,022,000	991,000	31,000
6. Worcester Area College Computation Center	234,000	322,000	(88,000)
7. Sponsored Research and Other Sponsored Programs	<u>659,000</u>	<u>679,000</u>	<u>(19,000)</u>
Totals	\$8,102,000	\$8,233,000	(\$130,000)
(1) Less: Restricted Auxiliary Operation Funds(Federal Loan Facilities)			-88,000
Net Unrestricted Profit			(\$218,000)

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\*All figures rounded to nearest \$1,000.



Of these items, nos. 2-7 are unlikely to be affected as budget items by installation of the new program. Item 2 represents dormitory, bookstore, and similar operations. Other education (item 3) refers to evening and summer programs, School of Industrial Management, Techniquest, and the Athletic Association. With the exception of summer school, these operations will not be materially affected by the program change, although there could be an effect on the evening program which is virtually impossible to estimate. Student aid and the Alden Research Laboratory expenses are not particularly oriented to the program, but it is clear that proper use of the Alden Laboratories could materially reduce some of the cost items given elsewhere. Item 6, the figure for the Computation Center, is determined by the cost of the Center rather than the program, and while the new program would undoubtedly increase use of the computer, the figure itself would be largely independent of the academic program.

The major item to be affected by the new program proposed is item 1, Education and General, which in the Audit Report is subdivided as follows:

A. General Administration	\$271,000
B. Student Services	228,000
C. Public Service and Information	136,000
D. General Institutional	206,000
E. Staff Benefits	453,000
F. Instruction and Departmental Research	2,623,000
G. Operation and Maintenance of Plant	<u>736,000</u>
Total Education and General	\$4,654,000

Item A includes salaries and expenses for the Trustees, President's Office, Dean of Faculty's Office, Director of Research, Director of Planning, Business Office, and Bursar's Office. This figure will undoubtedly be affected by the change in the organizational structure proposed, but no estimate can be given at this time.

Student Services, item B, consists of costs of the Office of Student Affairs, Admissions, Registrar, Placement, Health Service, and student activities. While these items will be affected somewhat by the new program, the effect cannot be fully estimated until the College environment has been worked out.



Item C includes the costs of the office of Development and Public Relations and the costs of publications, and is not considered to be affected by the program change per se.

The General Institutional Expense contains as major items bank management, insurance, legal and auditing fees, telephone, data processing, and staff recruitment.

The Staff Benefits expense includes, as major items, faculty and employee pension costs, Blue Cross-Blue Shield, Social Security, and Tuition for Faculty Children. This item (E) is directly influenced by the number and kind of faculty and staff employed by the college and will be affected by the program. For purposes of estimating this item, the ratio of Staff Benefits to total salaries and wages in the audit report will be used. While it is recognized that use of such a ratio assumes that the distribution of the various kinds of employees is not affected by the change in program, the fact that the new program requires an increased ratio of ancillary staff to faculty means that estimates so based will be conservative. The total salaries and wages is \$3,145,000 and the Staff Benefits figure is \$453,000. This makes the ratio for estimation of Staff Benefits 0.144.

Item G will not be significantly affected by the program at steady state operation.

The Business Office estimates that an additional annual expenditure of \$150,000 should be distributed throughout items A,B,C,E, and G for service personnel no matter what program is implemented.

Item F, Instruction and Departmental Research, is the major item to be affected by the new program and is a major item in the total expenses of the College. Included in the total, in addition to the salaries, wages and expenses of the several departments are: military science, physical education expenses, off-campus tuition, travel, miscellaneous, and the library. Of these items, salaries, wages, and expenses of the departments and of the library will be replaced by new figures. The expense item for the physical education department will also be retained since those costs are not replaced by the proposed projects and independent study work.



The departmental salaries and wages should be replaced by (2000 student base):

	<u>Minimum</u>	<u>Optimum</u>
Faculty Salaries (133)	\$1,678,000	\$1,678,000
Graduate Assistants (47)	116,000	116,000
Technicians (40-70)	343,000	600,000
Secretaries (14-33)	70,000	161,000
Administrative Assistants (8)	<u>100,000</u>	<u>100,000</u>
Total	\$2,307,000	\$2,655,000

The departmental non-salary expense of \$261,870.16 should be replaced by:

	<u>Minimum</u>	<u>Optimum</u>
Equipment*	\$ 215,000	\$ 247,000
Supplies and Expense*	<u>151,000</u>	<u>173,000</u>
Total	\$ 366,000	\$ 420,000

To these figures should be added items from the current non-salary expense which are not replaced by the projects:

Military Science	\$ 2,000
Physical Education	14,000
Off-campus tuition	4,000
Miscellaneous	<u>1,000</u>
	\$ 21,000

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\*These figures are based on an average of eleven research proposals with equipment at 10% and supplies and expense at 7% of salaries and wages plus 72% overhead. The resulting figures were then halved because it is assumed that on the average first and second year students would be assisting upperclassmen in experimental work. The resulting figures are considerably larger than obtained by estimates based on project-type courses in the College (see Appendix C).



As discussed in Appendix: C, the estimated costs for the library are:

Salaries and Wages	\$295,000
Supplies and Expense	<u>215,000</u>
Total	\$510,000

With the additional salaries and wages envisioned, the cost of Staff Benefits is computed as 0.144 times the total salaries and wages of the College, viz:

	<u>Minimum</u>	<u>Optimum</u>
Instruction	\$2,307,000	\$2,654,000
Library	295,000	295,000
Other (from Audit Report)	<u>1,099,000</u>	<u>1,099,000</u>
Total	\$3,701,000	\$4,048,000
Estimated Staff Benefits	533,000	583,000

With the above figures, the estimated Educational and General Expense becomes:

	<u>Minimum</u>	<u>Optimum</u>
General Administration	\$ 271,000	\$ 271,000
Student Services	228,000	228,000
Public Service and Information	136,000	136,000
General Institutional	206,000	206,000
Staff Benefits	533,000	583,000
Instructional	2,307,000	2,654,000
Salaries and Wages		
Equipment and Supplies (projects)	366,000	420,000
Equipment and Supplies (miscellaneous)	21,000	21,000
Library Salaries and Wages	295,000	295,000
Library Expense	215,000	215,000
Operation and Maintenance of Plant	<u>736,000</u>	<u>736,000</u>
Total	\$5,314,000	\$5,765,000
Increase	\$ 660,000	\$1,111,000

In considering this increased cost it is important to bear in mind that the more than 140% increase in library costs reflects some present inadequacies (cf. Appendix: E). Further, the estimated equipment and supplies



figures are considered generous. The Optimum estimate, in addition, reflects inadequacies in the present ancillary staff to a significant extent.

A possible Revenue and Expenditure statement can be expressed as follows:

	<u>Minimum</u>	<u>Optimum</u>
<u>Revenues</u>		
(Education and General)		
1500 Undergraduates	\$4,211,000	\$4,211,000
+ 500 additional undergraduates	<u>1,050,000</u>	<u>1,050,000</u>
	\$5,261,000	\$5,261,000
<u>Expenditures</u>		
(Education and General)		
1500 Undergraduates	\$4,654,000	\$4,654,000
+ increased cost of new program for 2000 students	<u>660,000</u>	<u>1,111,000</u>
	\$5,314,000	\$5,765,000
Additional Student Aid	<u>189,000</u>	<u>189,000</u>
Total Expense	\$5,503,000	\$5,954,000
Net Surplus	(\$ 242,000)	(\$ 693,000)

While both the minimum and optimum plans show a deficit, it is emphasized that some of the increased costs are a consequence of deficiencies in the present program. It is concluded that the minimum program is probably feasible, financially. Although the optimum program shows a sizeable deficit, the costs involved reflect some additional deficiencies in the present program. In any case, it is emphasized that fund raising should be aided materially by the uniqueness and goals of the proposed program.



## B: Equipment, "Supplies and Expenses" in Project Work

The cost of operating student projects can be estimated through experience with sponsored research and project work undertaken to date. While the actual costs will vary widely from project to project, some average figures can be developed to help forecast the incremental effect on equipment costs and those in the "Supplies and Expense" categories.

As an upper limit, it might be expected that about two-thirds of the students would be involved in the type of project which will involve laboratory or hardware orientation. Based upon the proposed budgets of eleven sponsored research programs undertaken in the past, equipment costs amounted to about 10% of the total budget while the "Supplies and Expense" item required about 7%. These percentages, when translated into figures involving total campus operation of the project program would indicate an annual equipment cost of 215,000 - 247,000 \$/year and an annual supplies and expense cost of 151,000 - 173,000 \$/year. It must be kept in mind, however, that these costs are based upon requirements for special graduate research work, whereas the undergraduate program would make wide use of existing general-purpose equipment and much less sophisticated supply items. It must also be remembered that these figures involve projected budgets for anticipated funding where requirements for equipment and supplies are seldom understated. It is, however, interesting to observe the ratios of costs involved.

There has already been experience in several project-oriented courses, two of which are described here. One was conducted entirely on campus, the other conducted in cooperation with industries, most of the work being done on campus. The Department of Chemical Engineering operated an on-campus project. In 1963 there was an initial outlay of \$1,800 for glassware, pipe and fittings, some of which is still in use. Following that initial outlay, the annual cost of operating the program has been about \$18.75 per student for supplies.

In the Department of Electrical Engineering there has been in operation for two years a course involving project work with 15 different industries. Approximately 45 students per year take the course. No new laboratory equipment has been required, since existing general purpose equipment has



been found to be quite adequate. Supplies have been in the nature of projection transparencies, small inexpensive components and telephone calls. A large supply of "war surplus" stock has proven helpful in providing breadboard components in some projects. The annual cost of supplies and expense might average \$5.00 per student. Many projects do, however, require special and sometimes expensive components. In each case to date the sponsoring company has either loaned or donated such items which have ranged from lighting fixtures to special purpose motors. One company established a \$1,500 budget for the project team which has been used in developing a large motor control system over two years of work. In another situation where weekly visits to their out-of-town plant were required, the company authorized the project team to submit travel expense vouchers in the same manner as their regular employees.

It might be concluded that the cost of maintaining a laboratory or hardware-orientated project program would likely range from \$5.00 to \$20.00 per student per year for supplies. Costs exceeding these figures should be considered in a category which would require assistance from a supporting agency.

It has proved very difficult to obtain a clear picture of the overall situation relative to laboratory equipment on the campus, since all equipment is in the custody of the several departments. While there appears reasonable cooperation in the exchange of equipment, there also appears to be a degree of reluctance to request the assistance of another department in equipment matters. Generally, the faculty of one department have very little idea of the laboratory capabilities of other departments. There is an obvious need for a campus-wide, computerized index of laboratory equipment classified in a manner which would make the existence, state of repair, and availability of equipment a matter of record for all interested workers in the College. A central equipment control system will be necessary to increase the equipment utilization level in a large project program. While students should certainly be taught to respect good equipment, and abuse of it never tolerated, there appears to have been such emphasis on protecting



equipment from students in the past that there has been a tendency for equipment to become obsolete without ever playing a significant part in the educational process.

While new equipment will be constantly needed in the total project program, this item should not present a significantly different cost involvement than that currently experienced in existing up-to-date laboratories. The equipment would be used more, and therefore have a shorter useful life. This effect, however, may be more than offset by the development of much closer relationships with industries and agencies which, realizing the needs of the College, will make more gifts of desirable, "state-of-the-art" equipment. One initial equipment need, however, will be in the form of a variety of small hand tools and fabrication devices, averaging, it is estimated, about \$10 per student the first year and \$3 per year thereafter. The role of Washburn Shops could be greatly increased to support new activities in prototype development.



### C. Estimated Library Costs

In the June 16, 1966 Library Committee report submitted to the Dean of Faculty, a library expansion program was outlined. The Library Committee recommended as a realistic working size that our holdings be increased to 90,000 volumes by 1971 and to 105,000 volumes by 1975. Thus, the new planning model (calling for 135,500 volumes) is asking for an additional 30,500 volumes. However, recalling that the 105,000 figure is based on data that did not fully account for the increased activity in the Master's and Doctoral programs at WPI, it is realistic to charge only a fraction of the additional requirement to the new program - a 50 percent figure seems appropriate, i.e. 15,000 volumes.

Costs for additional library personnel "rendering service to students and faculty" and special services would be higher under the model program. A measure of this increase can be obtained from the library budget figures for 1967, 1968, and 1969 which gave a library budget to book and journal ratio of approximately 2.86 to 1.00. The new model calls for a ratio of 3.4 to one reflecting a slightly higher percentage (16%) of the total library budget being allocated for personnel and services. ( a cost figure of  $\$510,000 \times .54/3.4 = \$81,000$  for the year 1975)

A parallel operation or library enrichment program will be required to bring our holdings to a 135,300 volume figure by 1975. At the suggested rate of increase by 1975 we would have approximately 105,000 volumes requiring approximately 30,500 volumes to complete a reasonable working library.

The proposed model budget does not reflect the purchase of audio visual equipment, reading machines, film loop readers and other possible teaching aids necessary to put that aspect of the operation into effect (one time estimate = \$18,000). In addition it does not reflect the purchase of typewriters, desks, chairs, shelving, carrels, tables, chairs, etc. (one time estimate = \$20,000).

If the model program is effected, it might be time to adopt the basement of the Gordon building for library use as originally contemplated.



Current holdings

Books and bound journals as of June 30, 1969	56,517
Microform Volumes	1,000
Unbound Journals	5,000
	<hr/>
	62,517

Formula from Association of American Colleges for estimating a minimal collection of senior College and University Libraries

1. Undergraduate collection	50,750
2. Faculty members x 100 = 150 x 100	15,000
3. Students x 12 = 2000 x 12	24,000
4. Undergraduate Students in honors or independent study x 12 = 1500 x 12	18,000
5. Masters Work	3,050
6. Doctors Work	24,500
	<hr/>
Total Volumes	135,300

Net additions needed

$$135,300 - 62,517 = 72,783 \text{ volumes}$$

Recent Library Budgets (from Business Office)

fiscal year ending	6/30/67	6/30/68	6/30/69
Salaries; Wages, Casual Wages	64,758.14	103,009.58	109,541.49
Books and Periodicals	74,668.10	128,338.86	80,274.65
Other	<u>12,129.02</u>	<u>17,812.44</u>	<u>20,830.27</u>
Total	151,555.26	249,160.88	210,646.41

Ratio total budget to

Books and Periodicals	2.03	1.94	2.86
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NOTE: This shows an approximate 20% increase per year, discounting 1968 with its unusual gifts.



Suggested Five Year Library Budget

Fiscal Year Ending	<u>Lib. Budget</u>	<u>Books</u>	<u>Journals</u>	<u>Total</u>	<u>Book and Journal Cost</u>	Ratio of Lib. Budget to <u>Book &amp; Journal Cost</u>
1971	\$300,000	5000	1000	6000	\$105,000	2.85
1972	345,000	5500	1125	6725	116,250	2.96
1973	400,000	6000	1250	7250	127,500	3.14
1974	460,000	6500	1375	7875	138,750	3.31
1975	510,000	7000	1500	<u>8500</u>	150,000	3.40
				36,350		

Library holding at end of five years (i.e. 1975 if we start in 1970).

As of June 1969	62,517
Estimate 1970	6,000
5 year additions	<u>36,350</u>
	104,867



D: Costs involved for Technicians Supporting the Educational Program

The proposed model with its emphasis on interdisciplinary project work will require the support of various technicians to a substantially greater degree than the present program. It is important to estimate the level of this required technical support, for it represents a major cost.

Before this estimate is presented, however, an important consideration should be mentioned. The necessary increase of 80 - 100% in faculty salaries in the past 10 - 15 years has created severe financial problems for almost all private institutions of higher learning. There now is a great hue and cry for increased efficiency in the educational program. Since faculty salaries are a direct cause of the problem, solutions might be found from examination of this major expense area. Part of the solution is painfully obvious. Colleges, to an extent which few businesses can possibly afford, use their relatively highly paid professional staffs to perform services that could and should be undertaken by technicians and clerical help. Professors do their own typing; research supervisors do their own instrumentation work. Examples are so numerous and familiar that no listing is required, and WPI is certainly no exception to the usual case. It seems obvious that to promote financial solvency in the future, private colleges are going to have to hold back enlargement of their professional staff, while increasing the number of technicians and clerical staff. A major educational efficiency will result when professionals are used as professionals and not as technicians or secretaries.

It follows directly that the level of technical support at WPI has been inadequate. It is true that the project vehicle requires a substantial increase in technical support. Most of this increase, however, is required for a financially efficient operation regardless of program, and it would be unfair to charge the total cost of an adequate technical support staff to the proposed model.

It is difficult to estimate accurately the number of technicians required to support the proposed model. Perhaps the best approach is to present bounds on the number of required technicians. For a lower bound the technicians



could be used to supervise and advise the project experimental work, while the project students would actually act as their own technicians. This, while perhaps not an optimum situation, is certainly not a bad limiting case. The experience gained by the students would be quite valuable if not carried to extremes.

Under the assumption that there are 510 projects on campus at any given time, two-thirds of which involve model building or experimental work at some stage, it seems reasonable to estimate that about one-third of those involved are actually building hardware or in the laboratory at any given time. Thus as an approximation, 115 of the total 510 projects would require technician support at any given time. If it is assumed that a technician can concurrently supervise three projects, with the students performing the work, then forty technicians are required to support the project program.

Current Technician Support at WPI by Department

<u>Department</u>	<u>No. of Full-time Technician</u>
Civil Engr.	0
Chemistry	0
Chemical Engr.	1
Electrical Engr.	2.5
Mechanical Engr. (excluding Alden Lab.)	6
Physics	2
	<hr/>
Total	11.5

For an upper limit on technical support, some research facilities estimate adequate support as one technician for each full-time research professional. From section V-C of this report, there would be approximately ninety full-time equivalent faculty doing project supervision under the proposed model. Thus, for an upper bound, ninety technicians would be required. This figure, however, assumes that the student performs relatively few technician services himself, and this might in fact be detrimental to his educational program. Perhaps 70 technicians would represent a reasonable optimum.



E: Costs Involved with Construction of Project Work Areas

With the proposed program, it is anticipated that much of the intellectual focus for the student will be provided by the project experience. It is important that these student groups have access to semi-private areas for their meetings and work. Providing such areas will result in construction costs that can be estimated as follows. Approximately 200 work areas, 10' x 10' each, ought to be provided. Renovation costs for work areas with separating partitions, not full walls, might be estimated at \$6 per square foot. A table, chairs, and file cabinet for each area would be about \$200. The total expense for 200 areas would be about \$160,000.

As a lower bound on work space cost, project teams would not be supplied work areas but only with storage cabinets in existing laboratories. This cost at \$100 a cabinet would be \$20,000.